

Shiftwork, stress, and psychosomatic complaints: a comparison between workers in different shiftwork schedules, non-shiftworkers, and former shiftworkers

By MICHAEL FRESE* and NORBERT SEMMER†

* Department of Psychology, University of Munich, Leopoldstrasse 13, 8000 Muenchen 40, F.R. Germany

† Federal Health Office, Institute of Social Medicine and Epidemiology, Werner-Voss-Damm 62, 1000 Berlin 42, F. R. Germany

In a questionnaire study of 3446 blue-collar male workers in the chemical industry of the Federal Republic of Germany, shift- and non-shiftworkers were compared for reported health and stress at work. There were three groups of non-shiftworkers: former shiftworkers who left shiftwork because of a physician's advice, former shiftworkers who were not so advised, and never-shiftworkers. Both shiftworkers and former shiftworkers who left for health reasons showed a higher degree of reported ill health than never-shiftworkers and former shiftworkers who had left for other reasons than health. The results are consistent when stress at work and other potentially confounding factors are controlled. However, stress at work is an important predictor of ill health independent of shiftwork. Furthermore, a rapidly rotating 12-hour shift system (rotating every 2 to 3 days) as compared with a slower rotating 8-hour shift system (rotating every 5 to 7 days) showed no significant differences in workers' ill health when stress at work and skills were controlled.

1. Introduction

Night and shiftwork is of increasing importance in highly industrialized and developing countries. However, there are potentially negative effects of night and shiftwork (Ulich and Baitsch 1979). The idea that shiftwork must have some negative effects on health has been a popular notion but research, at least at the cross-sectional level, has been surprisingly inconclusive (cf. Rutenfranz *et al.* 1981). Often, no differences have been found between shiftworkers and non-shiftworkers. There are at least three possible explanations for these results even if shiftwork is indeed a risk factor for health: selection of shiftworkers, lower stress at work for shiftworkers, and the social context of the study. These three possibilities will be examined in this paper.

The most prominent explanation is the selection hypothesis. Persons who have become sick or are likely to become sick by continuing shiftwork leave, or are asked to leave by their employers or by their physicians. The remaining shiftworkers form a select group of particularly healthy people. This 'healthy worker effect' is reinforced by medical examinations and medical selection of future shiftworkers. This is a standard practice, at least in larger European companies (Haider *et al.* 1981).

In some studies, attempts have been made to control for this selection effect by including former shiftworkers in the research design (e.g. Koller *et al.* 1978). This is an important step but it may not be sufficient. Many former shiftworkers have really left shiftwork for reasons other than health, for example to get a better job or to be able to pursue leisure activities that conflict with shiftwork. These people should not be included in a group that controls for the healthy worker effect. To assume without further examination that health is the most important reason for leaving shiftwork

could lead to underestimates of the health consequences of shiftwork. Frese and Okonek (1984) have, therefore, argued that one should differentiate between those who left shiftwork for health reasons and those who left for other reasons.

A second potential explanation for finding no differences between shift and non-shiftworkers pertains to those stressors at work that are not shift related (in the following the shorthand term 'stress at work' is used for them). One could argue that there are many aspects of 'quality of work life' (such as well designed jobs, little environmental stress, good communication) that influence health. These aspects might offset the potentially negative effects of night and shiftwork. Indeed, there are some positive aspects of this kind that may be linked to nightwork. Night shifts are usually not as tightly supervised, workers are better able to help each other at night, and the more strenuous tasks are usually done in the daytime.

However, depending upon the specific job and the company, one could also argue the converse. Shiftworkers might have to endure harder working conditions, higher noise level, higher speed requirements at work, etc. Thus, if stress at work is not controlled for, one might find the shiftworkers to be relatively healthy in the first instance whereas they would be less healthy in the second.

The results of studies that do not control for working conditions are, therefore, difficult to interpret. This applies even to studies which otherwise have a rather sophisticated design. Taylor and Pocock (1972), for instance, used a retrospective longitudinal design in which shiftworkers, dayworkers, and ex-shiftworkers were traced, and the deaths and the causes of death noted. They concluded that shiftwork has no adverse effects. There are only two cases, however, in which they equated for occupation. Of these two, one (skilled maintenance workers) showed differences in mortality between night and day workers, and the other did not. Equating for occupation, therefore, makes their results inconclusive. Occupation is, at best, only a very crude index of working conditions because conditions may be quite different for different jobs within the same occupational domain (Frieling 1977). That the inclusion of this crude indicator casts doubt on the general conclusion of this study, reinforces the need to control for stress at work. This is further highlighted by Dirken's (1966) finding that there is a wide range for the correlation coefficients between shiftwork/non-shiftwork and environmental stress in different factories, with a low of -0.14 to a high of $+0.41$. The impact of working conditions other than shiftwork itself on ill health deserves, therefore, more attention than it has so far received.

The third potential reason for inconclusive results is the social context. Answers to a questionnaire on health issues must be seen in the social context in which they are given. To a certain extent, at least, the answers might depend upon the hypotheses the respondents have about the study. Even if the study is anonymous they might be suspicious; for example, if a study is carried out by the company doctor, the workers might be afraid of becoming victims of their own responses. They might hypothesize that the company would introduce regular medical examinations if too many shiftworkers show illnesses in the questionnaire. These examinations could lead to dismissals or removals from the well paid night and shiftwork. Answers that reveal illness would be avoided in such a case. This might be one reason why the study of Loskant (1970) (a company doctor employed by a large corporation) generally showed the lowest levels of ill health as compared with other shiftwork studies (cf. the overview of Rutenfranz *et al.* 1981). This is not to imply that the respondents were lying, but rather that they were trying to keep their answers 'on the safe side'. In cases of doubt, the context of the study could influence workers' answers. In a study (such as this one)

supported or carried out by the labour unions, the context factors might work the opposite way. That is, the problems and difficulties of doing shiftwork could be emphasized to support the labour union's policy. Those people holding offices in the labour union probably want to promote the goals of the labour union most strongly; therefore, they might be influenced most strongly by the context factors of this study. If this reasoning is valid there should be differences in the answer patterns between officers in the labour union, ordinary members, and nonmembers of the union. It is therefore necessary to control for the influence of this contextual factor.

These factors—selection, stress at work, and the social context of the study—which might contribute to inconclusive results with regard to shiftwork in general, are also important when comparing specific effects of different shift schedules. Two shift schedules that are prominent in the chemical industry in F.R. Germany were compared: the quickly rotating 12-hour shift schedule and the more slowly rotating 8-hour shift schedule (Loskant 1970, Rutenfranz *et al.* 1975). A typical 12-hour shift schedule allows at least one free day after one or two night shifts; then, following the free day(s), there are one, two, or three day shifts. The 8-hour schedule typically involves shift periods for five to seven days, after which there are several days off. Loskant (1970) and Rutenfranz *et al.* (1975) have argued that the 12-hour schedule has medical advantages: given that a total inversion of the circadian rhythm is not possible under ordinary circumstances of shiftwork a short period of night shifts is least disturbing to the circadian rhythm (Knauth and Rutenfranz 1976).

Loskant's (1970) findings seem to support this line of argument. Workers in the quickly rotating 12-hour shift system showed fewer health problems. These results, however, are particularly prone to the confounding of stress and shift. The 12-hour schedule requires a special permit that is usually granted only when the working conditions are not very stressful and when a certain part of the work day is spent in alert time. The finding that workers in the company with the 8-hour shift system report higher levels of noise indicates that, indeed, work may have been more stressful in this company.

In order to control for these problems—selection, confounding of stress and shift, and social context—in the study of the relationship between shiftwork and ill health, the following strategy of research and analysis was used:

- (1) *Comparison groups.* To control for the selection effect, shiftworkers were compared with (a) workers who had never worked shifts, (b) workers who had previously worked shifts but ceased because their physician had told them to, and (c) workers who left shiftwork for reasons other than health.
- (2) *Statistical control of confounding effects.* The following confounding factors were statistically controlled: (a) stress at work, (b) age and level of training, and (c) social context variables, namely 'proximity to labour union' (non-members, members, members with an office such as shop steward), and return rate of company.

These controls were used to assess both the effects of night and shiftwork in general and the differential effect of the 12- versus 8-hour shift schedules.

2. Sample

2.1. Sampling procedure

A scientific study group for the chemical labour union in the Federal Republic of Germany arranged for the distribution of questionnaires in 24 factories. These 24

companies were selected from 69 companies whose local labour union had expressed an interest in participating in the study. They are representative of the areas in which the union *Industriegewerkschaft Chemie, Papier, Keramik* operates. About half the factories in the sample produce chemical products while the rest are distributed among the rubber, synthetic, paper, glass, and ceramics industries. The union organizes blue and white-collar workers of all occupations and it is by far the largest and most influential union in these areas of production.

The following procedure was chosen to select study participants. Shop stewards distributed consent forms. Their instructions were to make an extra effort to approach former shiftworkers and workers who did not belong to the labour union. Furthermore, they were asked to give the consent forms only to native German speakers. Those workers who returned their consent forms received the questionnaire. Each factory was allotted a certain number of consent forms. This amounted to a sample of 15% of all the shiftworkers and 5% of the non-shiftworkers. The minimum number of consent forms distributed in each factory was 100. Thus, the smaller factories were oversampled and the larger ones undersampled.

There were two reasons why the use of a random sample was not feasible. First, the random sample could only have been drawn from the labour union register. Using this register would have restricted the sample to members of the labour union, making it impossible to control for context factors. Second, the register does not give a breakdown into shiftworkers and non-shiftworkers; thus, a random sample would not have allowed a large enough sample of former shiftworkers.

Of those who received the questionnaire, 61.5% returned it ($N = 5448$). The return rate was identical for shiftworkers and non-shiftworkers but it ranged widely across the different factories (from 27 to 100%). As is true of other applied research projects, it is difficult to estimate the 'real' refusal rate since workers could refuse to sign the consent form and we could only ascertain the return among those who had signed. On the other hand, the shop stewards reported a relatively high degree of willingness of the employees to participate in the study and to fill out the consent forms.

The following steps were taken to homogenize (and reduce) the sample for the analyses reported in this article: (1) only male, blue-collar workers were included in the analyses; (2) the group of shiftworkers was composed only of workers whose schedules included work at night; and (3) the group of former shiftworkers was restricted to those who had once worked nights. Two groups of former shiftworkers were distinguished according to their answer to the question, 'Has a physician advised you to quit shiftwork?'. The group that said *yes* was considered to be leaving shiftwork because of health reasons, and the group who said *no* was considered to have left shiftwork for other reasons. This distinction leads to the following groups of male blue-collar workers (abbreviations in parentheses):

- 1295 shiftworkers with 8-hour shifts (8-hour shiftworkers);
- 1198 shiftworkers with 12-hour shifts (12-hour shiftworkers);
- 693 workers, who never worked in shifts (never-shiftworkers);
- 108 former shiftworkers who left because of health reasons on a physician's advice (Leavers-HR);
- 152 former shiftworkers who left for reasons other than health; that is, they did not report a physician's advice to leave shiftwork (Leavers-OR).

As there were missing data, some of the analyses were performed with smaller numbers.

2.2. Demographics

There were no differences between the two groups of shiftworkers with regard to length of service (14.5 versus 14.3 years of shiftwork). The Leavers-HR, however, had worked shifts for more years than the Leavers-OR (10.3 versus 7.0 years prior to their current jobs; $F(1,255) = 14.3, P < 0.001$). These two groups did not differ with regard to the time spent in daywork after leaving shiftwork (9.2 versus 10.5 years, n.s.). There were significant age differences among the groups. The means were 40 years for 12-hour shiftworkers and 8-hour shiftworkers, 37 years for never-shiftworkers, 45 years for Leavers-HR, and 41 years for Leavers-OR ($F(4,3105) = 20.0, P < 0.0001$). Age, therefore, was included as an additional control variable. There was a slight overrepresentation of union members in the sample: 88% compared to a baseline of 74% in those companies. There was also an overrepresentation of active union members who held offices in the labour union or related to the labour union (28% had such a function).

3. Methods and instruments

The following scales* were used (based on the stress scales by Semmer (1982) and the ill-health scales by Mohr (1985)): (1) environmental stress (ten items, e.g. 'How much stress is there due to noise at your work place?'): Cronbach's Alpha = 0.84; (2) psychological stress (six items, e.g. 'How often are you under time pressure in your work?'): Alpha = 0.80; (3) psychosomatic complaints (nine items, e.g. 'Do you have headaches?'): Alpha = 0.84; this is a short form of the *Freiburger Beschwerdeliste* by *Fahrenberg* (1975), slightly adapted by *Mohr* (1985); (4) irritation/strain (four items, e.g. 'Are you rather nervous when you come home tired?'): Alpha = 0.88; and (5) health complaints over the last two years (ten items, e.g. 'I had diseases of the stomach or bowels within the last two years'): this is a summation index and therefore no Alpha was computed. All the other variables (age, etc.) were single items.

All the scales were pretested in pilot studies (*Projekt Schichtarbeit* 1980). The items were on a five-point scale using an equal interval answer format except in those cases in which the content of the items did not allow this. The answer formats were taken from *Rohrman* (1978), who empirically studied equidistancy between differing answer possibilities. The stress indices were validated with observers in another study, and the correlations of the subjective versions used in this report with the ratings by trained observers were 0.57 for environmental stress and 0.41 for psychological stress (*Semmer* 1982).

With sample sizes as large as the one this report is based upon, power is increased so that differences that are statistically significant may be practically irrelevant. To minimize this danger the relatively conservative criterion of $P \leq 0.001$ was uniformly used (cf. *Cohen* 1969). An exception is in the significance level for the *Scheffé* test, which is very conservative (*Winner* 1962), where a significance level of $P < 0.01$ was used. The issue of the practical importance of the results will come up again in the discussion.

4. Results

4.1. Comparison between shiftworkers and the other groups

The differences in skills, reported ill health, and stress at work among the different groups are described in table 1.

* The items and item values can be obtained from M.F. on request.

Table 1. Skills, stress, and ill health in two groups of shiftworkers, two groups of former shiftworkers, and never-shiftworkers.

	Shiftworkers		Leavers		Never-shiftworkers	F or χ^2 -value
	12-hour	8-hour	HR	OR		
Skills						
No trade learned (%)	11	14	18	8	6	$\chi^2_{(4)} = 39^{**}$
Skilled job (%)	46	33	47	58	81	$\chi^2_{(4)} = 403^{**}$
How much skill necessary in job† (mean)	3.82	3.81	3.52	3.75	3.87	$F_{(4,3119)} = 4.6^*$
Stress at work						
Environmental† (mean)	2.67	2.81	2.71	2.60	2.70	$F_{(4,2855)} = 5.6^*$
Psychological† (mean)	3.63	2.67	3.43	3.48	3.44	$F_{(4,3119)} = 19.3^{**}$
Ill health						
Psychosomatic complaints† (mean)	2.51	2.62	2.77	2.11	2.18	$F_{(4,3069)} = 27.7^{**}$
Irritation/Strain† (mean)	2.71	2.88	3.06	2.27	2.32	$F_{(4,3061)} = 34.5^{**}$
Complaints of last two years‡ (mean)	2.76	3.02	3.53	2.58	2.68	$F_{(4,3144)} = 11.31^{**}$

* $P < 0.001$, ** $P < 0.0001$.

† Mean of item(s) scaled from 1 to 5.

‡ Lowest value = 0, highest value = 9.

4.1.1. *Skills.* Two different kinds of skills were ascertained: the formal training* (first question in table 1) and the skill requirements in present job (questions 2 and 3). On all of the indicators, the never-shiftworkers are better skilled than the other groups, the most clearcut differences appearing in the comparison of formal skills. The Leavers-OR are also well educated. The Leavers-HR have the lowest education and comparatively little skill in their present jobs.

4.1.2. *Stress at work.* Although both environmental and psychological stress show significant *F*-values, clearcut differences are found only with regard to psychological stress.

4.1.3. *Ill health.* In the three scales of ill health, the five groups fall primarily into two groups: on the one side there are shiftworkers and the Leavers-HR, and on the other side are the never-shiftworkers and the Leavers-OR. This division is significant (Scheffé test) for psychosomatic complaints and irritation/strain but is not upheld by the scale on health complaints for the last two years, in which manifest pains and illnesses were

* There is a formal difference in Germany between people who have learned a trade (skilled workers) and people who have been trained on the job (the term 'semi-skilled worker' is used here). As the trade of 'skilled chemical worker' has been introduced only recently, most of the skilled workers will have learned a trade for another occupation than the one they are presently working in. With regard to the German educational system, having learned a trade or not can be considered a good indicator of education in the blue collar sector.

Table 2. Ill health in two groups of shiftworkers, two groups of former shiftworkers, and never-shiftworkers: comparison of individual items (percentages).

	Shiftworkers		Leavers		Never-shiftworkers	χ^2 -value
	12 hour	8 hour	HR	OR		
Psychosomatic complaints†						
Strong signs of fatigue	61	56	60	44	46	127**†
Sleep disturbances	41	43	37	20	19	405**†
Feel tired and worn out whole day	43	41	49	21	24	202**†
Irritation/Strain						
Nervous, when coming home tired	46	47	57	32	32	139**†
Feel like a nervous wreck	26	25	37	13	14	92**†
React with irritation, even when I do not want to	39	40	49	25	27	131**†
Quickly angered	34	35	40	22	22	93**†
Complaints of last two years†						
Lung disease	4	3	14	4	3	33**§
Disease of stomach and bowel	40	48	47	36	37	28**§
Heart disease	17	19	36	16	15	27**§
Heart pain of 1 to 15 min duration	27	32	39	22	26	18*§
Trouble breathing during heart pain	11	14	31	8	9	43**§
High blood pressure	27	33	34	22	27	n.s.

* $P < 0.001$, ** $P < 0.0001$.

Note. Percentages are given to make items comparable to other studies. The categories 'practically always' and 'every few days' were combined except for 'Complaints over last 2 years' which had a yes/no format.

† Selected items.

‡ d.f. = 16.

§ d.f. = 4.

assessed. Here the Scheffé test indicates that the Leavers-HR are more unhealthy than the other groups (with the exception of the 8-hour shiftworkers). In table 2, the items of psychosomatic complaints that most clearly differentiate the groups, the items of irritation/strain, and the most important complaints of the last two years are presented (in percentages, for ease of comparisons with other studies). Shiftworkers and Leavers-HR show high values for fatigue, for sleep disturbances, and for feeling tired and worn out during the day, compared with the never-shiftworkers and Leavers-OR. The results are similar for irritation/strain; about twice as many shiftworkers and Leavers-HR feel 'like a nervous wreck' as in the other two groups. Diseases of the bowel and stomach are slightly more frequent in the shiftworkers and Leavers-HR. The Leavers-HR have a higher prevalence of heart disease (36%) and lung disease (14%) than do the other groups.

4.1.4. *Controlling for confounding.* The following potentially confounding variables were used in an Analysis of Covariance (ANCOVA): psychological and environmental stress at work, self-reported skill level ('How much skill is necessary in the job?'), age, labour union membership, and return rate (cut-off point 70%). The first three variables were used as covariates; since labour union membership and return rate were categorical, they were added as additional factors.

The results of the ANCOVA* confirm the hypothesized relations of shiftwork with psychosomatic symptoms and with irritation/strain†. Here, the adjusted and observed means are very similar. The results are not significant, however, for health complaints in the last two years. Furthermore, as shown in table 3, membership in the labour union (i.e., whether or not one is a member or office holder in the labour union) and return rate have no effect on ill health. None of the interactions is significant.

The division of the five groups into subgroups is also supported by further analysis of the ANCOVA. The subgroup of never-shiftworkers and Leavers-OR differs significantly from the subgroup of shiftworkers and Leavers-HR with regard to psychosomatic complaints ($T = -4.31$, $P < 0.0001$) and for irritation/strain ($T = -4.00$, $P < 0.001$).

4.2. Effects of stress at work, skill, and age

Although the control variables have little influence on the relations between shiftwork and ill health, they do have a direct relationship with ill health. The strongest effect is that of psychological stress which has highly significant standardized regression coefficients with all the dependent variables (as shown in table 4). Environmental stress has somewhat smaller, but still significant, relations even when all the other effects are controlled. The effects of age and skill level are, on the whole, rather small.

4.3. Comparison of 8-hour with 12-hour shiftworkers

Table 1 also displays the differences between the two shift schedules. There are only small differences between them. The shiftworkers with the quickly rotating 12-hour shift schedule are a little more skilled than the 8-hour shift workers. They also show a somewhat smaller degree of environmental stress. Finally, 12-hour shiftworkers are slightly healthier than the 8-hour workers. An analysis of variance (ANOVA) without any controls shows that these differences are marginally significant in the cases of psychosomatic complaints ($F(1,2132) = 8.6$, $P = 0.004$) and of irritation strain ($F(1,2137) = 9.0$, $P = 0.003$) and significant for complaints over the last two years ($F(1,2194) = 13.4$, $P < 0.001$). Since the differences between these two shift schedules were small in other studies as well, these results seem to reproduce their findings. However, when the potential confounding variables (stress, skills, age, labour union, return rate) were included in an ANCOVA comparing the two shift schedules, even these small differences disappeared and the results were not even marginally significant.

Another way of evaluating the impact of different shift schedules is to compare former shiftworkers according to the shift schedules which they once worked. Thus, in an additional two-way ANOVA, the group of former shiftworkers who worked on a 12-hour schedule ($N = 166$) was compared with former shiftworkers who worked on an 8-hour shift schedule ($N = 80$) on the three ill-health variables. The familiar two groups of former shiftworkers were distinguished, as well—Leavers-HR and Leavers-OR. Only

* Because of unequal N s in the cells, each sum of squares is adjusted for all other effects.

† One could argue that only the large differences between the two groups of former shiftworkers produce the significance in the ANCOVAs reported so far. To rule out this interpretation another ANCOVA was run, excluding the former shiftworkers (otherwise, the same independent variables and covariates were used). This ANCOVA leads to the same significant differences in ill health between shiftworkers and never-shiftworkers—only the F -values are slightly higher with this analysis.

Table 3. Analysis of covariance ($N = 2741$). Independent variables: shiftwork, union membership, return rate. Dependent variables: ill health. Covariates: environmental and psychological stress at work, age, skill.

Independent variables	Psychosomatic complaints†			Irritation/strain†			Complaints over last two years†		
	Mean			Mean			Mean		
	Obs.	Adj.	F-value	Obs.	Adj.	F-value	Obs.	Adj.	F-value
Shiftwork									
(1) Never	2.17	2.27	7.48**	2.31	2.43	5.70**	2.66	2.83	1.27
(2) Leavers OR	2.10	2.15		2.25	2.31		2.56	2.60	
(3) Leavers HR	2.71	2.67		3.01	2.95		3.47	3.35	
(4) 8-hour shift	2.62	2.54		2.87	2.76		3.05	2.97	
(5) 12-hour shift	2.48	2.46		2.68	2.64		2.75	2.74	
Union membership	—	—	1.83	—	—	1.59	—	—	2.19
Return rate	—	—	1.23	—	—	0.13	—	—	0.20
Regression	—	—	134.09**	—	—	110.61**	—	—	82.20**

Note. All interactions are nonsignificant; the observed and adjusted means are based on an ANCOVA without the factors union membership and return rate.

* $P < 0.001$, ** $P < 0.0001$.

† Lowest value = 1, highest = 5.

‡ Lowest value = 0, highest = 9.

Table 4. Significant standardized regression coefficients of stress at work, skills, and age with ill health.

	Psychosomatic complaints	Irritation/strain	Complaints of last two years
Psychological stress	0.33	0.35	0.19
Environmental stress	0.16	0.11	0.12
Self-reported skill	-0.10	-0.12	—
Age	0.10	—	0.19

All coefficients displayed are significant (lowest $T = 5.7$, $P < 0.0001$). They were calculated as part of the ANCOVA shown in table 3.

this factor showed the familiar significant differences but there were no such differences in the factor, 'shift schedule'. There was no significant interaction effect. Here, again, there are no robust ill-health differences between the 8-hour and 12-hour shift schedules.

5. Discussion and conclusion

Summarizing the overall effects, one can detect two subgroups: shiftworkers and Leavers-HR on the one hand, and never-shiftworkers and Leavers-OR on the other. Controlling for stress at work, age, and skill level does not dramatically change the results. Only the results for 'health complaints over the last two years' become nonsignificant—a measure which generally shows the weakest effects. The results for psychosomatic complaints and irritation/strain stay essentially the same. With regard to the social context, there are no significant effects of membership in the labour union or of return rate. This adds credibility to the results. Apparently, response bias due to the social context or selection bias were negligible in this study.

Psychological and environmental stress are strongly related to the three scales of ill health (similar to other studies on stress at work, cf. e.g. Frese 1985). This implies that stress may well add to the effects of shiftwork. The necessity of extending the analysis of shiftwork to working conditions in general, if one wants to be able to draw clearcut conclusions, is therefore underlined by our results.

Age and level of skill are less strongly related. One reason for the rather small regression coefficient of age may lie in the 'healthy worker effect'. Workers who become sick with age retire early or otherwise leave work, thus reducing the variance on the ill-health variables. Although direct effects of these control variables on ill health could be observed, these covariates very little affect the influence of shiftwork on ill health.

Our results support the conclusion that the design of shiftwork studies should include former shiftworkers. The finding that former shiftworkers tend to show more signs of ill health than other groups has been reported in other studies (e.g. Aaonson 1964, Angersbach *et al.* 1980, Koller *et al.* 1978, Mott *et al.* 1965), but the samples of former shiftworkers in these studies have usually been small. Our study goes beyond this by further dividing the group of former shiftworkers according to the reasons for leaving shiftwork. This usually has not been done. An exception is Aanonon's study (1964) and his findings are in accordance with ours: those who left shiftwork on a physician's advice show more complaints than the other group.

One may still wonder whether the health problems of the Leavers-HR are really due to shiftwork: after all, they were out of shiftwork for an average of nine years. One might argue that they must have been sick before they began working shifts. This interpretation does not seem very likely for a number of reasons, however. First, there is usually a medical examination before workers start shiftwork. This should screen out at least the more extreme cases. Secondly, even if a case of illness is not detected by this screening, medical problems should arise after a short time, leading to a physician's advice to leave shiftwork. However, the Leavers-HR worked shifts for an average of 10.3 years.

Another interpretation would be that the Leavers-HR became sick after having left shiftwork, for example because of high stress in their present working conditions. This is, however, not likely: an inspection of table 1 indicates that Leavers-HR have a level of environmental stress not substantially higher than the never-shiftworkers. The level of psychological stress, which is the more important predictor, is similar for all the non-shiftworkers including the Leavers-HR and substantially lower than for the shiftworkers. Thus, current stress at work cannot explain why Leavers-HR have high levels of ill health. This adds credibility to their reports that health reasons were responsible for their leaving shiftwork.

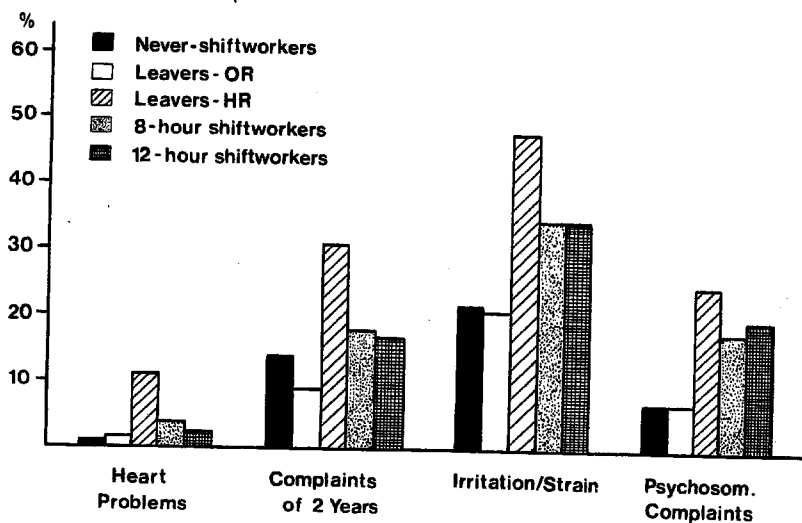
Another interpretation is, therefore, suggested: the Leavers-HR became sick (at least in part) because of shiftwork and have remained sick from then on. This interpretation is feasible because of the long time they spent in shiftwork and their somewhat higher values on 'health complaints over the past two years' which is the measure of illness and complaints of long duration. This is also in line with the results of Koller *et al.* (1978), that former shiftworkers show an elevated response to noise long after having left shiftwork. Thus, it seems quite plausible that this group worked shifts up to their biological/psychological breaking-points (Frese and Okonek 1984). Once this breaking-point is reached (and diagnosed by a physician), the illnesses persist even after the switch to daywork.

With regard to the comparison of the two groups of shiftworkers, our data call into question Loskant's (1970) and Nachreiner and Rutenfranz's (1975) findings, in which the 12-hour shift system was determined to be superior in terms of health effects. While this difference between our study and theirs may partly be due to the fact that we included only blue-collar workers in the analysis, their case does not appear to be very strong. Their health variables are measured with single items of questionable reliability. Also, the differences between the two shift systems in the better of the two studies (Nachreiner and Rutenfranz 1975) are not very large—as is the case in ours. Finally, they did not control for potentially confounding variables such as stress, age, and skill level—a procedure which in our data renders the already small differences negligible. Thus, our findings suggest that, at least from the perspective of ill health, an introduction of the 12-hour shift system may be less advantageous than expected*. This note of caution is similar to that given by Pocock *et al.* (1972).

* It should be added, however, that this does not mean that the workers do not prefer the quickly rotating 12-hour shift schedule to the slower 8-hour schedule. Results with a scale on 'readiness to change the shift schedule' that are not reported here show that the 12-hour shiftworkers are less interested in change than the 8-hour shiftworkers (Projekt Schichtarbeit 1981). This is also in line with other research (Nachreiner and Rutenfranz 1975, Walker 1966). But we suspect that the reasons for preferring the 12-hour shiftwork schedule do not lie in its health effects but instead in its added leisure time, since commuting time is reduced.

There are two additional problems that have still to be considered: (1) are the results of practical importance, and (2) could a 'complaint without substance' factor explain the self-reported results? It is not easy to determine the practical importance of correlations and mean-scale differences. Statistical significance tests are not sufficient since practically trivial differences may be statistically different in large sample studies like ours. Typically, what is deemed to be an important mean difference is at least partly a political and social decision (e.g. what is the amount of additional suffering that shiftworkers are expected to endure for their additional pay?). One prerequisite for practical relevance is knowing how many people are *seriously* impaired. An (arbitrary) cut-off point was therefore used to determine serious impairment: a person's score of 3.5 or higher on the five-point scales of both psychosomatic complaints and irritation/strain and the report of five or more illnesses and complaints in the last two years. The percentages of seriously impaired persons in each group are shown in the figure.

Comparing shiftworkers with never-shiftworkers, serious psychosomatic complaints are 2.5 times higher and irritation/strain is more than 50% higher in the shiftwork groups. The differences are not of the same magnitude for health complaints over the last two years. With regard to Leavers-HR versus never-shiftworkers, the differences are even stronger. Percentages are 3.5 times higher for psychosomatic complaints and more than double for irritation/strain and for health complaints over the last two years in Leavers-HR than in the never-shiftworkers. Taken together, we feel that these differences should be considered to be important. To use a medical



Serious impairment of never-shiftworkers, Leavers-OR, Leavers-HR, 8-hour and 12-hour shiftworkers (percentages). Cut-off points: heart problems: yes to four questions; complaints over last 2 years: five or more illnesses reported; irritation/strain: 3.5 and higher on a 5-point scale; psychosomatic complaints: 3.5 higher on a 5-point scale. (Leavers-HR: former shiftworkers who left for health reasons; Leavers-OR: former shiftworkers who left for other reasons).

analogy: a medicine that reduces the frequency of illness by 50% would probably be considered to be of practical importance. In the light of the results of studies predicting mortality discussed below, this analogy does not appear to be unjustified.

An additional variable, 'heart problems', was included in the figure as a composite measure of four items of the index on complaints over the last two years (presented in table 2): self-reported heart disease, heart pain, trouble breathing during heart pain, and high blood pressure. This index is included here because it is similar to that used by Karasek *et al.* (1981) in predicting subsequent death from coronary heart diseases. People who reported two or more of these signs of heart disease had a fivefold higher mortality rate from coronary heart disease and atherosclerotic disease than expected in the study by Karasek *et al.* Taking an even stronger criterion, namely, answering yes to all the four items of this index, the figure shows that there are many more Leavers-HR who gave an affirmative answer to all four questions than there were in any of the other groups.

The study of Karasek *et al.* also gives an answer to the second question, 'How seriously should we take results from questionnaire studies?' The questionnaire index of Karasek *et al.* proved to be as good a predictor of coronary heart disease mortality as an electrocardiogram. In comparison with an interview by a physician, the questionnaire is a somewhat conservative instrument. The questionnaire 'produced no false positive responses but missed a significant number of mild symptoms reported to the physician' (Karasek *et al.* 1981, p. 696). This result corresponds to the comparison of Meltzer and Hochstim (1970) between self reports and medical ratings which shows that there is generally a larger number of false negatives than false positives in questionnaire answers. Questionnaire research may therefore actually underestimate, rather than overestimate, the true health problems of the respondents. Other studies (Mossey and Shapiro 1982, Waldron *et al.* 1982) corroborate the finding that global subjective health ratings are good predictors of actual mortality (sometimes better than the physicians' ratings). Thus, this literature supports the view that questionnaire responses should be taken seriously, although it is preferable to use 'harder' criteria like mortality rates and physical examinations in studying the potential effects of shiftwork.

One might argue that these findings of other studies do not apply to shiftwork studies because the shiftworkers may be motivated to report negative health consequences of shiftwork. Field studies cannot refute this argument. However, it is reasonable to assume that different people would have different motivations for their reports. Active labour union officials might have the highest motivation to influence labour union policy and public opinion. The factor Union Membership, however, does not approach significance in the ANCOVA. Although these results do not prove that motivated answers did not appear, they make such a systematic bias less likely.

In summary, this study shows that there were health differences between shiftworkers and never-shiftworkers and that these differences did not disappear when potentially confounding variables were controlled for. Additionally, the former shiftworkers who left on physicians' advice were similar to the shiftworkers in the reported ill-health scores while those who left for other reasons were not. Differences between shift systems could not be substantiated. While stress was not a factor that strongly reduced the relationship between shiftwork and ill health, stress at work itself had strong correlations with the three indicators of ill health. While we are not able to answer questions of cause and effect with this cross-sectional study, it appears that one should seriously consider two areas as potential occupational health risk factors: shiftwork and stress at work.

Acknowledgments

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A partir d'une enquête par questionnaire portant sur 3446 travailleurs manuels en travail posté dans l'industrie chimique en Allemagne Fédérale, on a comparé les ouvriers postés à ceux qui ne l'était pas, sur la base de l'évaluation de leur état de santé et de stress ressenti au travail. On a disposé de trois groupes d'ouvriers non postés: (a) d'anciens ouvriers postés ayant abandonné ce système pour des raisons médicales; (b) d'anciens ouvriers postés l'ayant abandonné pour des raisons autres que médicales et (c) des ouvriers n'ayant jamais travaillé par équipes alternantes. Les ouvriers postés ainsi que les anciens postés ayant abandonné pour des raisons médicales ont fait état de plus de problèmes de santé que les 'jamais postés' ou les anciens postés ayant abandonné pour des raisons non médicales. Les résultats sont concordants lorsqu'on tient compte du stress au travail et d'autres facteurs susceptibles d'intervenir. Cependant le stress au travail est un important prédicteur de santé déficiente, indépendamment du travail posté. En outre, la comparaison du système d'équipe de 12 heures à rotation courte (tous les 2 à 3 jours) et du système de 8 heures à rotation plus longue (tous les 5 à 7 jours) montre qu'il n'y a pas de différence significative entre les deux en ce qui concerne les problèmes de santé, lorsqu'on tient compte du stress au travail et de la pratique acquise.

In einer Befragung von 3446 männlichen, blaugekleideten Schichtarbeitern der chemischen Industrie in der DDR wurden sowohl Schichtarbeiter als auch Nicht-Schichtarbeiter hinsichtlich selbstbenannter Gesundheit und dem Stress bei der Arbeit verglichen. Es gab drei Gruppen von Nicht-Schichtarbeitern: Frühere Schichtarbeiter, die ihre Schichtarbeit auf ärztlichen Rat hin aufgegeben hatten, frühere Schichtarbeiter, die diesen Ratschlag nicht erhalten hatten. Sowohl Schichtarbeiter als auch die ehemaligen Schichtarbeiter, die aus gesundheitlichen Gründen aufgehört hatten, schrieben sich einen schlechteren Gesundheitszustand zu, als die Vergleichsgruppe derjenigen, die noch keine Schichtarbeit durchgeführt hatte und ehemalige Schichtarbeiter, die aus anderen als gesundheitlichen Gründen aufgehört hatten. Die Ergebnisse bestätigten sich, als Stress bei der Arbeit und andere—durchaus überraschende—Faktoren kontrolliert wurden. Der Stress stellt bei der Arbeit stets einen wichtigen Anzeiger verminderter Gesundheit dar, unabhängig von der Schichtarbeit. Ein 12-Stunden System der Schichtarbeit (Rotation alle 2–3 Tage) zeigte darüberhinaus im Vergleich mit langsamer rotierender 8-Stunden Schicht (Rotation alle 5–7 Tage) bei Kontrolle von Stress und Können keine signifikanten Unterschiede des Gesundheitszustandes der Arbeiter.

西ドイツの化学工場働く交替制勤務男性労働者 3,446 名のアンケート調査より、報告された健康状態と作業時のストレスについて交替制勤務労働者とそうでない労働者との比較を行った。交替制勤務でない労働者群は、以前交替制勤務についていたが医者からの指示で他に変わった群、その様な指示がなく変わった群、そして交替制勤務に一度もついていたことのない群の 3 群からなる。交替制勤務労働者と健康上の理由から変わった群の両群とも交替制勤務についたことのない群及び健康上以外の理由で交替制勤務から他に変わった群と比較し、健康上の不調の訴えが高かった。作業時のストレスと他の影響因子をコントロールした時結果が一貫性を示す。しかし、作業時のストレスは交替制勤務とは無関係の健康上の不調の重要な予測因子の一つである。さらに、作業時のストレスと技能レベルをコントロールした場合、回転のはやい 12 時間交替制勤務システム (2–3 日で交替する) と回転の遅い 8 時間交替制勤務システム (5–7 日で交替する) との間で作業者の健康上の不調の訴えに有意な差は見られなかった。

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Erratum

Shiftwork, stress, and psychosomatic complaints: a comparison between workers in different shiftwork schedules, non-shiftworkers, and former shiftworkers. By MICHAEL FRESE and NORBERT SEMMER, 1986, *Ergonomics*, **29**, 99-114.

The correct version of the German summary is as follows:

In einer Fragebogenuntersuchung von 3446 männlichen Schichtarbeitern der chemischen Industrie in der Bundesrepublik Deutschland wurden Schichtarbeiter und Nichtschichtarbeiter auf den Variablen selbst-berichtete Gesundheit und Stress in der Arbeit verglichen. Es gab drei Gruppen von Nichtschichtarbeitern: Frühere Schichtarbeiter, die aufgrund eines ärztlichen Rats Schichtarbeit aufgegeben hatten, frühere Schichtarbeiter, bei denen dies nicht der Fall war und Nieschichtarbeiter. Sowohl Schichtarbeiter als auch solche früheren Schichtarbeiter, die aus gesundheitlichen Gründen aufgehört hatten zeigten eine geringere Gesundheit als die Vergleichsgruppe, die noch nie Schicht gearbeitet hatte und die Gruppe der ehemaligen Schichtarbeitern, die aus anderen als aus gesundheitlichen Gründen die Schichtarbeit verlassen hatte. Diese Ergebnisse bestaetigen sich, wenn Stress in der Arbeit und andere potentiell konfundierende Faktoren kontrolliert werden. Allerdings ist Stress in der Arbeit, unabhängig von der Schichtarbeit, ein wichtiger Prädiktor für verminderte Gesundheit. Darüberhinaus zeigte der Vergleich eines schnell rotierenden 12-Stunden Schichtsystems (Rotation alle 2 bis 3 Tage) mit einem langsam rotierenden 8-Stunden Schichtsystem (Rotation alle 5 bis 7 Tage) keine signifikante Unterschiede im Gesundheitszustand der Arbeiter, wenn Stress in der Arbeit und Qualifikation kontrolliert wurden.

Errata:

Please note that the German translation of the abstract is completely wrong; the correct version should read:

In einer Fragebogenuntersuchung von 3446 männlichen Schichtarbeitern der chemischen Industrie in der Bundesrepublik Deutschland wurden Schichtarbeiter und Nichtschichtarbeiter auf den Variablen selbst-berichtete Gesundheit und Stress in der Arbeit verglichen. Es gab drei Gruppen von Nichtschichtarbeitern: Frühere Schichtarbeiter, die aufgrund eines ärztlichen Rats Schichtarbeit aufgegeben hatten, frühere Schichtarbeiter, bei denen dies nicht der Fall war und Nieschichtarbeiter. Sowohl Schichtarbeiter als auch solche früheren Schichtarbeiter, die aufgrund von gesundheitlichen Gründen aufgehört hatten, zeigten einen höheren Grad selbstberichteter Gesundheitseinbußen als die Vergleichsgruppe, die noch nie Schicht gearbeitet hatte und die Gruppe der ehemaligen Schichtarbeitern, die aus anderen als aus gesundheitlichen Gründen die Schichtarbeit verlassen hatte. Diese Ergebnisse bestaetigen sich, wenn Stress in der Arbeit und andere potentiell konfundierende Faktoren kontrolliert werden. Allerdings ist Stress in der Arbeit, unabhängig von der Schichtarbeit, ein wichtiger Prädiktor für verminderte Gesundheit. Darüberhinaus zeigte der Vergleich eines schnell rotierenden 12-Stunden Schichtsystems (Rotation alle 2 bis 3 Tage) mit einem langsam rotierenden 8-Stunden Schichtsystem (Rotation alle 5 bis 7 Tage) keine signifikante Unterschiede des Gesundheitszustands der Arbeiter, wenn Stress in der Arbeit und Qualifikation kontrolliert wurden.